

A new species of *Simulium* (*Hellichiella*) from Kyoto, Japan (Diptera: Simuliidae)

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Abstract: *Simulium* (*Hellichiella*) *chiharuae* sp. nov. is described on the basis of adults, pupae and mature larvae collected in Himuro, Kyoto, Japan. This is the first species of the subgenus *Hellichiella* recorded from Japan. This new species is distinguished from other members of this subgenus by the pupal gill with three slender filaments per side.

Key words: *Simulium*, black fly, Simuliidae, Japan, description, *Hellichiella*

The subgenus *Simulium* (*Hellichiella*) Rivosecchi and Cardinali consists of 22 known species in the Holarctic Region (Adler et al., 2004). In Japan, one species of this subgenus was reported under the name *Eusimulium* sp. 2 from Himuro, Kyoto by Onishi et al. (1971). This species has remained unnamed and undescribed.

In this paper, it is described as a new species on the basis of the reared adults, pupae and mature larvae recently collected from Himuro, Kyoto.

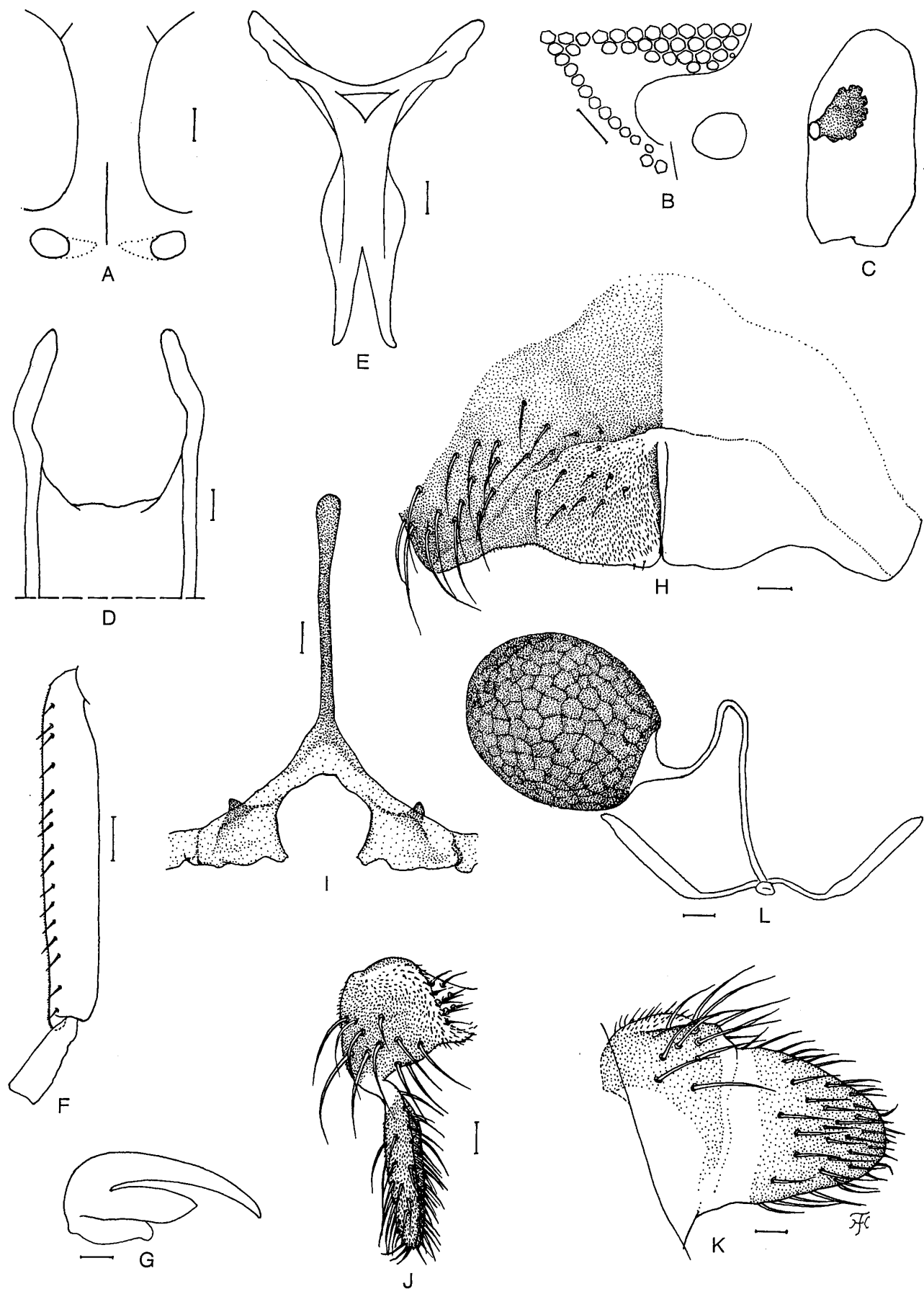
The terms for morphological features used here follow those of Takaoka (2003). Holotype and paratype specimens of the new species are deposited at the Department of Infectious Disease Control, Oita University, Oita, Japan.

Simulium (*Hellichiella*) *chiharuae* sp. nov.

Eusimulium sp. 2 Onishi, Uemoto and Orii, 1971: 106–107.

DESCRIPTION. Female. Body length 2.8 mm. **Head.** Narrower than thorax. Posterior surface of head densely covered with yellow-

ish-white hairs intermixed with several dark brown hairs near vertex. Frons (Fig. 1A) brownish-black, dull, densely covered with yellowish-white recumbent hairs interspersed with a few dark brown hairs along each lateral margin. Frontal ratio 1.6 : 1.0 : 2.9. Frons-head ratio 1.0 : 6.9. Fronto-ocular area (Fig. 1B) well developed, triangular, directed laterally and upwardly. Clypeus brownish-black, dull, densely covered with yellowish-white recumbent hairs interspersed with several dark upright hairs on each side except near dorsal margin bare medially. Labrum 0.51 times as long as clypeus. Antenna composed of scape, pedicel, and 9 flagellomeres, entirely brownish-black; scape nearly as wide as 1st flagellomere, densely covered with fine hairs except dorsal and dorsolateral surfaces almost bare; 1st flagellomere about 1.5 times as long as 2nd one. Maxillary palp consisting of 5 segments, blackish, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.14 : 2.15; 3rd segment (Fig. 1C) of moderate size, with sensory vesicle ellipsoidal, 0.24 times as long as 3rd segment, with medium-sized opening. Maxillary lacinia with 15–17 inner and 17–19 outer teeth. Mandible with 34 inner and 14 outer teeth. Cibarium (Fig. 1D) without any tubercles near posterodorsal margin. **Thorax.** Scutum brownish-black to black, slightly shiny when illuminated



at certain angle of light, densely covered with brilliant yellowish-white recumbent hairs interspersed with several dark brown upright hairs on prescutellar area. Scutellum brownish-black, with several dark brown upright hairs as well as yellowish-white shorter hairs. Postnotum brownish-black, slightly shiny at certain angle of light and bare. Lateral surface of thorax brownish-black, slightly shiny at certain angle of light and bare. Pleural membrane medium brown and bare. Katepisternum longer than deep, brownish-black and bare. Furcasternum (Fig. 1E) without apodeme directed downward on each arm. **Legs.** All brownish-black to black; coxae, trochanters, femora and tibiae moderately to densely covered with yellowish-white hairs mostly on outer and posterior surfaces; fore basitarsus slender, slightly dilated, 8.42 times as long as its greatest width; hind basitarsus (Fig. 1F) nearly parallel-sided, 6.18 times as long as wide, and 0.69 times and 0.59 times as wide as greatest widths of hind tibia and femur, respectively; calcipala (Fig. 1F) developed, small, slightly shorter than its basal width; pedisulcus (Fig. 1F) weakly developed and shallow. Claw (Fig. 1G) with large basal tooth 0.57 times as long as claw. **Wing.** Length 2.6 mm. Costa with 2 parallel rows of dark short spinules as well as dark hairs except basal portion of costa with several whitish hairs. Subcosta with dark hairs except near apex bare. Basal portion of radius fully haired; R_1 with dark spinules and hairs; R_2 with dark hairs. Hair tuft on stem vein composed of dark brown hairs. Basal cell absent. **Abdomen.** Basal scale brownish-black, with fringe of yellowish-white long hairs. Dorsal and lateral surfaces of abdomen dark brown to brownish-black, densely covered with yellowish-white short hairs interspersed with dark ones on posterior segments; tergites 6–9 slightly shiny when illuminated at certain angle of light. Ventral surface of abdomen light to medium brown; segment 7 with very large dark brown sternal plate medially. **Genitalia.**

Sternite 8 (Fig. 1H) wide, bare medially but furnished with about 20 short to long hairs on each side. Ovipositor valves (Fig. 1H) nearly triangular, thin, membranous except inner margin narrowly sclerotized, densely covered with microsetae (except near posteromedial corners bare) interspersed with 9 or 10 short hairs; inner margins nearly straight and narrowly separated from each other. Genital fork (Fig. 1I) of inverted Y-form, with well sclerotized stem and wide arms; each arm with subrectangular lateral plate having short stout projection directed forward. Paraproct in ventral view (Fig. 1J) with medial 1/2 unsclerotized and 7–9 sensilla on inner bare surface; paraproct in lateral view (Fig. 1K) somewhat protruding ventrally beyond level of cercus. Cercus in lateral view (Fig. 1K) somewhat elongate, nearly as long as wide, and rounded posteriorly. Spermatheca (Fig. 1L) ovoidal, strongly sclerotized except area around juncture to duct and duct itself unsclerotized, with distinct polygonal surface pattern and without internal setae; both accessory ducts subequal in shape and size to each other, somewhat widened in diameter on apical 2/3, about twice as wide as main duct.

Male. Body length 3.3 mm. **Head.** As wide as thorax. Posterior surface densely covered with dark brown hairs. Holoptic; upper eye consisting of relatively large facets in 23 or 24 vertical columns and 24 or 25 horizontal rows. Clypeus brownish-black, dull, densely covered with ochreous fine hairs curved dorsally intermixed with dark longer hairs directed forward along lateral margins. Antenna nearly as in female; 1st flagellomere about 1.6 times as long as 2nd one. Maxillary palp dark brown, composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.05 : 2.07; 3rd segment (Fig. 2A) of moderate size; sensory vesicle (Fig. 2A) small, ellipsoidal, 0.09 times as long as 3rd segment, and with very small opening. **Thorax.** Scutum black, slightly shiny when illuminated at certain angle of light, densely

Fig. 1. Female of *Simulium (Hellichiella) chiharuae* sp. nov. A, frons; B, fronto-ocular area (right side); C, 3rd segment of maxillary palp with sensory vesicle (left side and front view); D, upper portion of cibarium (front view); E, furcasternum; F, basitarsus and second tarsal segment of hind leg showing calcipala and pedisulcus (left side and outer view); G, claw; H, 8th sternite and ovipositor valves *in situ* (ventral view); I, genital fork (ventral view); J and K, paraprocts and cerci *in situ* (right side; J, ventral view; K, lateral view); L, spermatheca. Scale bars. 0.08 mm for F; 0.04 mm for A, B and E; 0.02 mm for C, D, H–L; 0.01 mm for G.

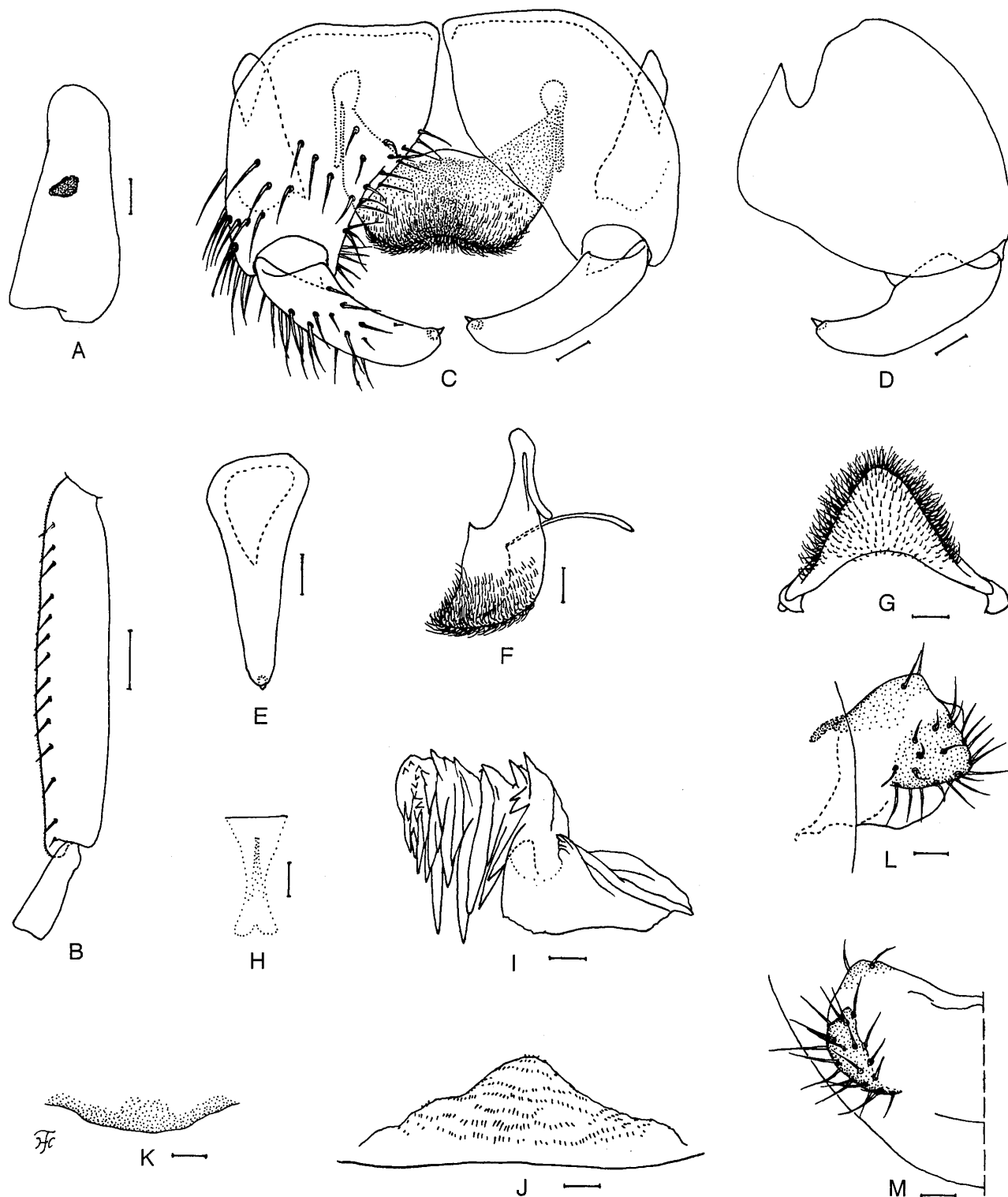


Fig. 2. Male of *Simulium* (*Hellichiella*) *chiharucae* sp. nov. A, 3rd segment of maxillary palp with sensory vesicle (left side and front view); B, hind basitarsus and 2nd tarsal segment showing calcipala and pedisulcus (left side and outer view); C, coxites, styles and ventral plate *in situ* (ventral view); D, coxite and style *in situ* (right side, lateral view); E, style (right side and posterolateral view); F, ventral plate and median sclerite *in situ* (lateral view); G, ventral plate (end view); H, median sclerite (end view); I, paramere (left side and end view); J, aedeagal membrane (end view); K, dorsal plate (ventral view); L and M, 10th abdominal segments with cercus (right side; L, outer view; M, end view). Scale bars. 0.1 mm for B; 0.02 mm for A, C-H and K-M; 0.01 mm for I and J.

covered with whitish-yellow to yellow recumbent hairs interspersed with several dark brown upright hairs on prescutellar area. Scutellum dark brown, with many dark brown upright long hairs. Postnotum brownish-black to black, slightly shiny when illuminated at certain angle of light, and bare. Lateral surface of thorax as in female. **Legs.** All brownish-black to black; fore basitarsus slender, cylindrical, 8.9 times as long as its greatest width; hind basitarsus (Fig. 2B) nearly parallel-sided though somewhat tapered near both ends, 5.1 times as long as its greatest width, and 0.71 times as wide as greatest width of hind tibia and femur; calcipala (Fig. 2B) small, shorter than its basal width; pedisulcus (Fig. 2B) very weakly developed, and shallow. **Wing.** Length 2.5 mm; other characters as in female (including haired subcosta) except costa without patch of pale hairs basally. **Abdomen.** Basal scale black, with fringe of light brown long hairs. Dorsal and dorsolateral surfaces of abdomen dark brown to brownish-black, not shiny, and densely covered with dull yellow to ochreous fine hairs intermixed with dark brown hairs; ventral surface of abdomen medium to dark brown except segment 2 ochreous. **Genitalia.** Coxite in ventral view (Fig. 2C) large, abruptly narrowed on posterior 1/2, about 1.5 times as long as greatest width; coxite in lateral view (Fig. 2D) large, gradually narrowed from base to apex, about 1.1 times as long as greatest width. Style in ventral view (Fig. 2C) short, very slightly tapered toward apex, with stout apical spine; style in posterolateral view (Fig. 2E) wedge-shaped about 0.8 times as long as coxite. Ventral plate in ventral view (Fig. 2C) lamellate, well sclerotized except narrow anteromedian area near anterior margin weakly or not sclerotized, with anterior margin convex and posterior margin concave, and densely covered with fine microsetae on posterior 1/2 of ventral surface; arm short, stout, and directed anteriorly; ventral plate in lateral view (Fig. 2F) somewhat produced ventrally near posterior margin; ventral plate in end view (Fig. 2G) triangular, moderately covered with fine microsetae on posterior surface. Median sclerite (Fig. 2H) simple, broad, bifurcated near apex. Paramere (Fig. 2I) with numerous short to long hooks. Aedeagal membrane (Fig. 2J) sparsely covered with minute setae; dorsal plate (Fig. 2K) thin, in form of broad transverse band. Ventral surface of 10th

segment (Fig. 2L) strongly sclerotized anterolaterally, and with 1 or 2 distinct hairs on each side. Cercus (Fig. 2L, M) darkened, with 18–22 simple hairs.

Pupa. Body length 3.2–4.0 mm. **Head.** Integument dark yellow, moderately covered with round tubercles; antennal sheaths bare; frons with 3 short and medium-long slender simple trichomes with uncoiled apex on each side; face with 1 medium-long somewhat stout simple trichome with coiled or uncoiled apex on each side. **Thorax.** Integument dark yellow to light brown, sparsely or moderately covered with round tubercles, with 3 medium-long somewhat stout simple trichomes with coiled apex mediodorsally, 2 medium-long simple trichomes (1 slender, with uncoiled apex, and 1 somewhat stout, with coiled apex) anterolaterally, 1 medium-long slender simple trichome with coiled or uncoiled apex mediolaterally, and 3 slender simple trichomes (1 medium-long, somewhat stout, with coiled or uncoiled apex, and 2 short, slender, with uncoiled apex) ventrolaterally, on each side (Fig. 3A). Gill (Fig. 3A) composed of 3 slender filaments, i.e., 1 dorsal individual filament (though 1 of 14 pupae examined had the left gill with dorsal filament further divided into 2 short branches apically) and 2 paired ventral filaments with short stalk arising from short common basal stalk; common basal stalk with transparent swollen organ ventrally; dorsal filament longest (variable in length including common basal stalk by individual pupae from 3.5 mm to 5.5 mm), inner filament of ventral pair shortest (also variable in length, 2.8–4.5 mm), and outer filament of ventral pair intermediate in length; dorsal filament directed upward, then forward and/or downward, ventral paired filaments directed downward, then forward, often close together; basal portion of dorsal filament at angle of 90 degrees or a little more to stalk of ventral paired filaments when viewed laterally; all filaments light grayish-brown, tapered toward tip, with distinct annular ridges and furrows forming reticulate patterns, and densely covered with minute tubercles. **Abdomen.** Dorsally, all segments yellowish to light brown, weakly sclerotized; segments 1 and 2 weakly tuberculate; segment 1 with 1 short slender hair-like seta on each side; segment 2 with 1 short slender hair-like seta and 5 short simple setae on each side; segments 3 and 4 each with 4 hooks and 1 short simple

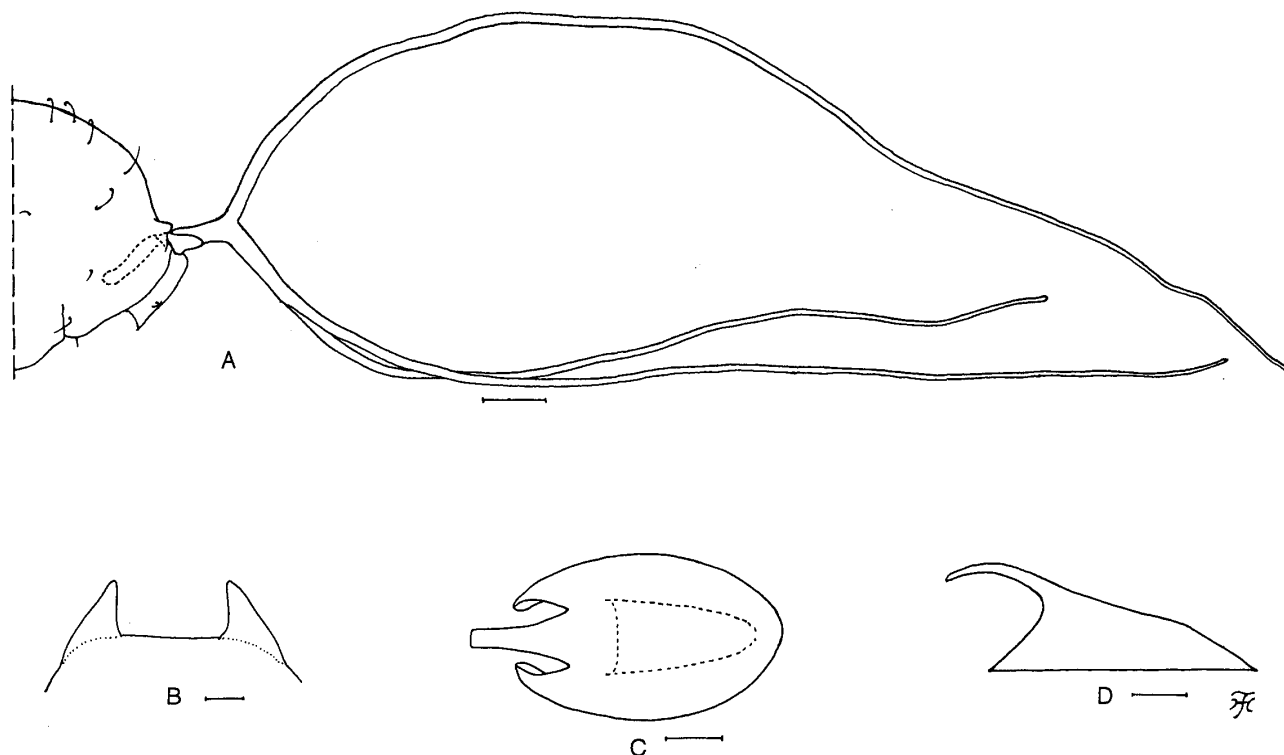


Fig. 3. Pupa of *Simulium (Hellichiella) chiharuae* sp. nov. A, gill filaments and anterior part of thorax (right side and outer view); B, terminal hooks (end view); C and D, cocoons (C, dorsal view; D, lateral view). Scale bars. 1.0 mm for C and D; 0.3 mm for A; 0.02 mm for B.

seta on each side; segments 5–9 each with spine-combs in transverse row (though spine-combs on segment 9 somewhat smaller than those on other segments) and comb-like groups of minute spines (often absent on segment 5) on each side; segment 9 with pair of distinct cone-shaped terminal hooks (Fig. 3B). Ventrally, segments 3–8 nearly transparent, with comb-like groups of minute spines; segment 3 with a few simple minute setae on each side; segment 4 with 1 simple hook (somewhat shorter than those on segments 5–7) and a few simple minute setae on each side; segment 5 with pair of simple inner and outer hooks submedially and a few simple minute setae on each side; segments 6 and 7 each with 1 simple hook submedially and 1 simple hook laterally and a few simple minute setae on each side. Segment 9 with 2 grapnel-shaped hooklets on each lateral surface. **Cocoon** (Fig. 3C, D). Wall-pocket-shaped, compactly woven without open spaces in web, extending ventrolaterally, and with elongate anterodorsal projection, individual threads invisible; 4.5–5.1 mm long (excluding anterodorsal projection) by 3.0–4.6 mm wide.

Mature larva. Body length 5.8–6.2 mm. Body light ochreous, without any marked color

pattern. Cephalic apotome (Fig. 4A) yellow, though slightly darkened along lateral and posterior margins; head spots medium to dark brown, though anterior portion of postero-lateral spots faint in some larvae. Lateral surface of head capsule (Fig. 4B) yellow, except eye-spot region white; eyebrow weakly defined, partially darkened, with 1 dark spot; several dark spots lying in vertical row just before posterior margin; 3 dark isolated spots present ventral and posterior to eye-spot region. Ventral surface of head capsule (Fig. 4C) yellow except basal area on each side of postgenal cleft darkened; dark horizontal and round spots present on each side of postgenal cleft. Cervical sclerite (Fig. 4A) composed of 2 small elliptical pieces, not fused to occiput, widely separated medially from each other. Antenna (Fig. 4D) consisting of 3 segments and apical sensillum, much longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.00 : 0.95–0.98 : 1.03–1.14; segment 2 with 4 annular hyaline hands. Labral fan with 64–68 main rays. Mandible (Fig. 4E) with mandibular serrations consisting of 1 main tooth and 1 small tooth followed by 1 or 2 small supernumerary teeth; main tooth at angle of 90 degrees or a little less with mandi-

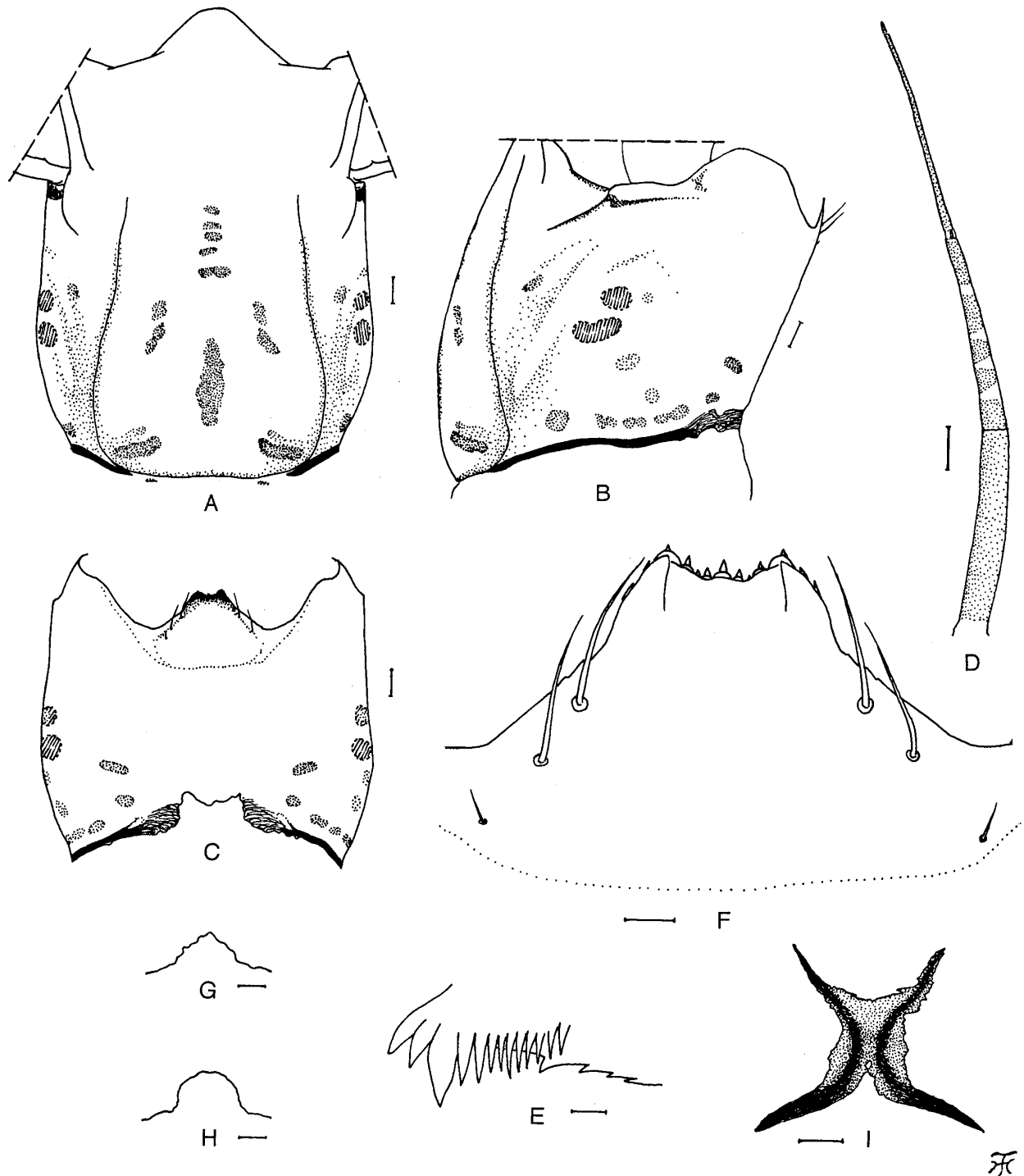


Fig. 4. Mature larva of *Simulium (Hellichella) chiharuae* sp. nov. A-C, head capsule (A, dorsal view; B, lateral view; C, ventral view); D, antenna (left side and dorsal view); E, apical part of mandible; F, hypostoma; G and H, postgenal clefts; I, anal sclerite (posterodorsal view). Scale bars. 0.05 mm for A-C, G and H; 0.04 mm for D and I; 0.02 mm for F; 0.01 mm for E.

ble on apical side; comb-teeth composed of about 10 teeth, decreasing in length from 1st to 3rd. Hypostoma (Fig. 4F) with 9 apical teeth and 4 anterolateral teeth in 3 groups; corner teeth highest, followed by median tooth and outer one of 3 intermediate teeth on each side; lateral serrations very weakly developed api-

cally; ventral wall with sulcus on each side; 2 long hypostomal bristles lying subparallel to lateral margin on each side; very short additional seta often present near each posterolateral corner. Postgenal cleft small, variable in shape, i.e., M-shaped (Fig. 4C) in 2 larvae, triangular (Fig. 4G) in 2 larvae, and round (Fig.

4H) in 1 larva. Thoracic cuticle bare. Abdominal cuticle bare except both sides of anal sclerite moderately or sparsely covered with simple colorless setae. Rectal scales absent. Rectal organ of 3 simple lobes. Anal sclerite (Fig. 4I) of usual X-form, with anterior arms nearly as long as posterior ones, broadly sclerotized at base; accessory sclerite absent. Ventral papillae well developed. Posterior circlet with about 64 rows of up to 14 hooklets per row.

TYPE SPECIMENS. Holotype female (with associated pupal exuviae and cocoon), reared from pupa, collected from a small ditch, Himuro Town, Kita-ku, Kyoto City, Japan, 1. IV. 2007, by H. Takaoka, Y. Otsuka and M. Fukuda. Paratypes: 10 females, 3 males, all reared from pupae, and 5 mature larvae, collection data same as those of the holotype.

BIOLOGICAL NOTES. The pupae and larvae of *S. (H.) chiharuae* sp. nov. were found on fallen leaves in a slow-flowing small ditch (width 5–20 cm, water temperature 11.0°C, exposed to sun, altitude 440 m) in rice fields in the mountainous area, northern suburbs of Kyoto. Associated species were *Prosimulium* (*Prosimulium*) *kiotoense* Shiraki and *Simulium* (*Nevermannia*) *uchidai* (Takahasi).

All the known species of the subgenus *Hellichiella* are univoltine and ornithophilic (Adler et al., 2004). It may be true for *S. (H.) chiharuae* sp. nov. but this remains to be confirmed.

ETYMOLOGY. The species name *chiharuae* is in honor of Ms. Chiharu Aoki, Department of Infectious Disease Control, Faculty of Medicine, Oita University, who greatly helped H. T. in studies of Simuliidae for many years.

REMARKS. *Simulium* (*H.*) *chiharuae* sp. nov. is assigned to the Holarctic subgenus *Simulium* (*Hellichiella*), redefined by Adler et al. (2004) by having the combination of the following characteristics: in both

female and male, scutum unpatterned, basal portion of the radial vein fully haired, and pedisulcus shallow (Fig. 1F and Fig. 2B); in female, claw with a large basal tooth (Fig. 1G), genital fork with lateral plates subrectangular, broadly jointed to corresponding tergite (Fig. 1I), and paraproct in ventral view with medial half unsclerotized (Fig. 1J); in male, style slender, evenly tapered apically (Fig. 2E), ventral plate in ventral view narrowed posteriorly (Fig. 2C), paramere with multiple hooks (Fig. 2I), and dorsal plate weakly sclerotized, in form of horizontal strip (Fig. 2K); in pupa, cocoon with an anterodorsal projection (Fig. 3C, D); in larva, antenna with four hyaline bands (Fig. 4D), hypostoma with anterior teeth arranged in three distinct groups (Fig. 4F), ventral wall of hypostoma bearing longitudinal sulcus on each side, abdominal segment 9 with prominent ventral papillae, and rectal organ of 3 simple lobes. It is striking that this new species bears only 3 pupal gill filaments per side (Fig. 3A) because all the known species of this subgenus are known to have 4 to 16 slender filaments per side (Adler et al., 2004).

Within the subgenus, this new species is placed in the *congarreenarum* species-group defined by Adler et al. (2004) by having the spermatheca (Fig. 1L) much longer than one half of the stem of the genital fork (Fig. 1I). This is the first description of a species of the subgenus *Hellichiella* from Japan.

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REFERENCES

- Adler, P. H., Currie, D. C. and Wood, D. M. 2004. The Black Flies (Simuliidae) of North America. xv + 941 pp., Cornell University Press, Ithaca, New York.
- Onishi, O., Uemoto, K. and Orii, T. 1971. On the new-recorded species of black fly (*Eusimulium*) from Japan (II). *Jpn. J. Sanit. Zool.*, 22: 106-107 (In Japanese).
- Takaoka, H. 2003. The Black Flies (Diptera: Simuliidae) of Sulawesi, Maluku and Irian Jaya. xxii + 581 pp., Kyushu University Press, Fukuoka.